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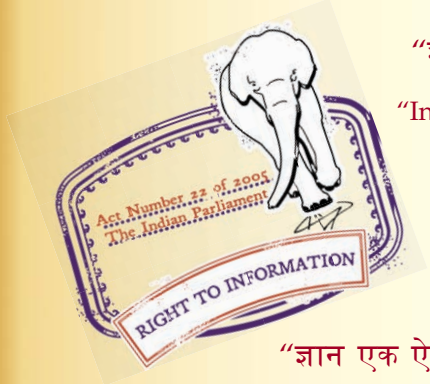
IS 10186 (1982): Recommendations for manual tungsten inert gas arc welding of copper and copper alloys [MTD 12: Welding Applications]



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IS : 10186 - 1982
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RECOMMENDATIONS FOR MANUAL TUNGSTEN INERT GAS ARC WELDING OF COPPER AND COPPER ALLOYS

UDC 621·791·754 : 669·3

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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January 1983

Indian Standard

RECOMMENDATIONS FOR MANUAL TUNGSTEN INERT GAS ARC WELDING OF COPPER AND COPPER ALLOYS

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(*Continued on page* 12)

Indian Standard

RECOMMENDATIONS FOR MANUAL TUNGSTEN INERT GAS ARC WELDING OF COPPER AND COPPER ALLOYS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 11 May 1982, after the draft finalized by the Welding General Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 With the publication of IS : 2812-1964* the provisions for manual tungsten inert gas arc welding aluminium and aluminium alloys have been covered. This standard covers similar provisions for copper and copper alloys.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the recommendations on materials, equipment and general workmanship for manual tungsten inert gas arc welding of wrought copper and copper alloys. The recommendations are primarily intended for general engineering application for manual welding of copper and copper alloys up to 20 mm thick with argon as the shielding gas.

1.1.1 This standard does not stipulate allowable stresses in welds. The provisions of this standard are also not applicable for repair of castings by welding.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 812-1957‡ shall apply.

*Recommendations for manual tungsten inert-gas arc-welding of aluminium and aluminium alloys.

†Rules for rounding off numerical values (*revised*).

‡Glossary of terms relating to welding and cutting of metals.

3. PARENT METAL AND FILLER WIRES

3.1 Following types of parent metals are covered in this standard:

Pure copper, silicon bronze, phosphor bronze, copper, nickel and aluminium bronze.

The alloys are indicated by the nominal composition in Table 1.

3.2 Filler Wires

3.2.1 The filler wires shall conform to the requirements of IS : 5898-1970*.

3.2.2 For the selection of filler wires for different copper and copper alloys, reference shall be made to Table 1. The recommended filler wires are intended for general applications.

TABLE 1 VARIOUS TYPES OF COPPER AND COPPER ALLOYS AND RECOMMENDED FILLER WIRES FOR WELDING

(*Clauses* 3.1 *and* 3.2.2)

Material	Parent Material: Typical Composition — Constituent	Parent Material: Typical Composition — Percent	Filler Wire (*see* IS : 5898-1970*)
Electrolytic tough pitch copper	Copper + Silver	99·90 *Min*	S-Cu 1
Phosphorus de-oxidised copper	Copper + Silver Phosphorus	99·80 *Min* 0·015-0·10	S-Cu 1
Silicon bronze	Silicon Zinc Tin + Manganese + Iron Copper	1·0-1·3 1·25 1·0 *Max* Remaining	S-Cu Si 1
Phosphor bronze	Tin Phosphorus Copper	3·0 to 7·0 0·02-0·4 Remaining	S-Cu Sn 2 S-Cu Sn 2
Aluminium bronze	Aluminium Iron Copper	3·0-13 2·5 *Max* Remaining	S-Cu Al 1 S-Cu Al 2 S-Cu Al 3
Cupro nickel	a) Nickel Copper	10·0 Remaining	S-Cu Ni 1
	b) Nickel Copper	20·0 Remaining	S-Cu Ni 2
	c) Nickel Copper	30·0 Remaining	S-Cu Ni 3

*Specification for copper and copper alloy bare solid welding rods and electrodes.

*Specification for copper and copper alloy bare solid welding rods and electrodes.

4. CURRENT CONDITION

4.1 Alternating current or direct current with electrode negative shall be used for welding copper and copper alloys.

4.2 Recommended current values for electrode and filler wire sizes chosen for different thicknesses of the copper and copper alloys are indicated in Tables 2 to 5.

5. WELDING TORCH

5.1 Air cooled torch with ceramic nozzle or water cooled torch with metal nozzle shall be used. For current values up to 200 amperes, air cooled torches may be used. For current values in excess of 200 amperes, water cooled torches shall be recommended.

6. ELECTRODES

6.1 The electrodes shall be made out of pure tungsten, thoriated tungsten or zirconiated tungsten.

6.1.1 In the case of dc power with the electrode negative thoriated tungsten or pure tungsten electrodes shall be used.

6.1.2 In the case of ac power source zirconiated tungsten or pure tungsten electrodes shall be used.

7. ARGON GAS

7.1 Quality — Argon gas used for the shielding purpose, shall conform to IS : 5760-1969*.

7.2 Flow Rate — The rate of flow of argon should be adequate to obtain a clean weld. This depends on several factors such as type of parent metal, current intensity, shape and size of nozzle, type of joint and where air draughts are present around the arc. Generally a higher rate of gas flow is required with higher welding currents, for corner joints, edge welds and work outdoors. Tables 2 to 5 give recommended flow rates for different weld thicknesses.

7.3 If welding has to be done outdoors during inclement weather, especially during period of high wind, the welding area should be effectively protected by increased gas flow rate. Draughts tend to break gas shielding, resulting in porous oxide contaminated welds.

8. PREPARATION OF PARENT METAL

8.0 Before welding, joints should be cleaned thoroughly to remove foreign matter, such as, oil, grease, dirt, paint, etc. This is usually achieved by degreasing or pickling or both followed by brushing.

*Specification for compressed argon.

TABLE 2 TYPICAL OPERATING DATA FOR TIG BUTT WELDS IN COPPER
(dc ELECTRODE — Ve, ARGON SHIELDING)

(*Clauses* 4.2, 7.2 *and* 11.1)

Thickness	Preheat Temp.	Electrode Diameter	Filler Rod Diameter	Gas Nozzle Diameter	Argon Gas Flow	Welding Current	No. of Passes	Remarks
mm	°C	mm	mm	mm	l/min	A		
1·5	—	1·6-2·4	1·6	9·5	4·6	80-130	1	Hot peening required
3	—	2·4-3·2	1·6	9·5-12	4-6	120-240	1-2	Hot peening required
6	Up to 400	3·2-4·8	3·2	12-18	6-8	220-350	2-3	Hot peening required
9	400-600	3·2-4·8	3·2	12-18	8-10	300-375	3-4	Hot peening required
12	400-600	4·8	3·2-4·8	12-18	8-10	330-420	4-6	Hot peening required
16-20	500-700	4·8	3·2-4·8	12-18	8-10	400-475	6-8	Hot peening required

TABLE 3 TYPICAL OPERATING DATA FOR TIG BUTT WELDS IN SILICON BRONZE
(ac, dc ELECTRODE — Ve)

(*Clauses* 4.2, 7.2 *and* 11.1)

Thickness	Preheat Temp.	Electrode Diameter	Filler Rod Diameter	Gas Nozzle Diameter	Argon Gas Flow	Welding Current	No. of Passes
mm	°C	mm	mm	mm	l/min	A	
1·5	—	3·2	1·6	9·5-12	5-8	100-130	1
3	—	3·2	2·4	9·5-12	5-8	120-160	1-2
6	—	3·2	3·2	12-18	8-10	200-300	2-3
9	—	3·2	3·2-4·8	12-18	8-10	250-300	3-4
12	—	3·2	3·2-4·8	12-18	8-10	270-330	4-6
16-20	—	3·2-4·8	3·2-4·8	12-18	8-10	300-375	6-8

TABLE 4 TYPICAL OPERATING DATA FOR TIG BUTT WELDING OF ALUMINIUM BRONZE
(ac, ARGON SHIELDING)

(*Clauses* 4.2, 7.2, 10·3 *and* 11.1)

Thickness	Preheat Temp.	Electrode Diameter	Filler Rod Diameter	Gas Nozzle Diameter	Argon Gas Flow Rate	Welding Current	No. of Passes	Remarks
mm	°C	mm	mm	mm	l/min	A		
1·5	—	3·2	1·6	9·5-12	5-8	100-130	1	Hot peening required
3	—	3·2	3·2	9·5-12	5-8	180-220	1-2	Hot peening required
6	150 *Max*	3·2	3·2	12-18	8-10	280-320	2-3	Hot peening required
9	150 *Max*	3·2	3 2-4·8	12.18	8-10	320-400	3-4	Hot peening required
12	150 *Max*	3·2	3·2-4·8	12-18	8-10	360-420	4-6	Hot peening required
16-20	150 *Max*	3·2	3·2-4·8	12-18	8-10	400-475	6-8	Hot peening required

TABLE 5 TYPICAL OPERATING DATA FOR TIG BUTT WELDS IN CUPRO NICKEL
(dc ELECTRODE — Ve, ARGON SHIELDING)

(*Clauses* 4.2, 7.2 *and* 11.1)

Thickness	Preheat Temp.	Electrode Diameter	Filler Rod Diameter	Gas Nozzle Diameter	Argon Gas Flow Rate	Welding Current	No. of Passes
mm	°C	mm	mm	mm	l/min	A	
1·5	—	3·2	1·6	9·5-12	8-10	100-140	1
3	—	3·2	3·2	9·5-12	8-10	140-200	1-2
6	150 *Max*	3·2	3·2-4·8	12-18	9-12	180-260	2-3
9	150 *Max*	3·2	3·2-4·8	12-18	9-12	260-320	3-4
12	150 *Max*	3·2	3·2-4·8	12-18	9-12	320-400	4-6
16-20	150 *Max*	3·2-4·8	3·2-4·8	12-18	9-12	360-450	6-8

8.1 Degreasing — Joints may be cleaned with solvent soaked rags to remove surface oil, grease, dirt, etc. Suitable solvents include carbon tetrachloride, acetone and trichloroethylene. It is essential to ensure that the components are completely dry of solvents before welding.

8.2 Pickling — Heavy oxide films may be cleaned by pickling. This should be done before welding.

8.3 Brushing — Following degreasing or pickling or both, the fusion faces of copper and its alloys should be scratch-brushed with wire brushes. These brushes should not have been used for scratch brushing materials other than copper and copper alloys. Stainless steel wire brushes are most suitable.

9. DESIGN OF EDGE FORMS

9.1 Recommended edge forms for butt joints up to 20 mm metal thickness are shown in Fig. 1.

9.2 Recommended types of tee-joints are shown in Fig. 2.

9.3 Recommended types of corner joints are shown in Fig. 3.

10. ASSEMBLY FOR WELDING

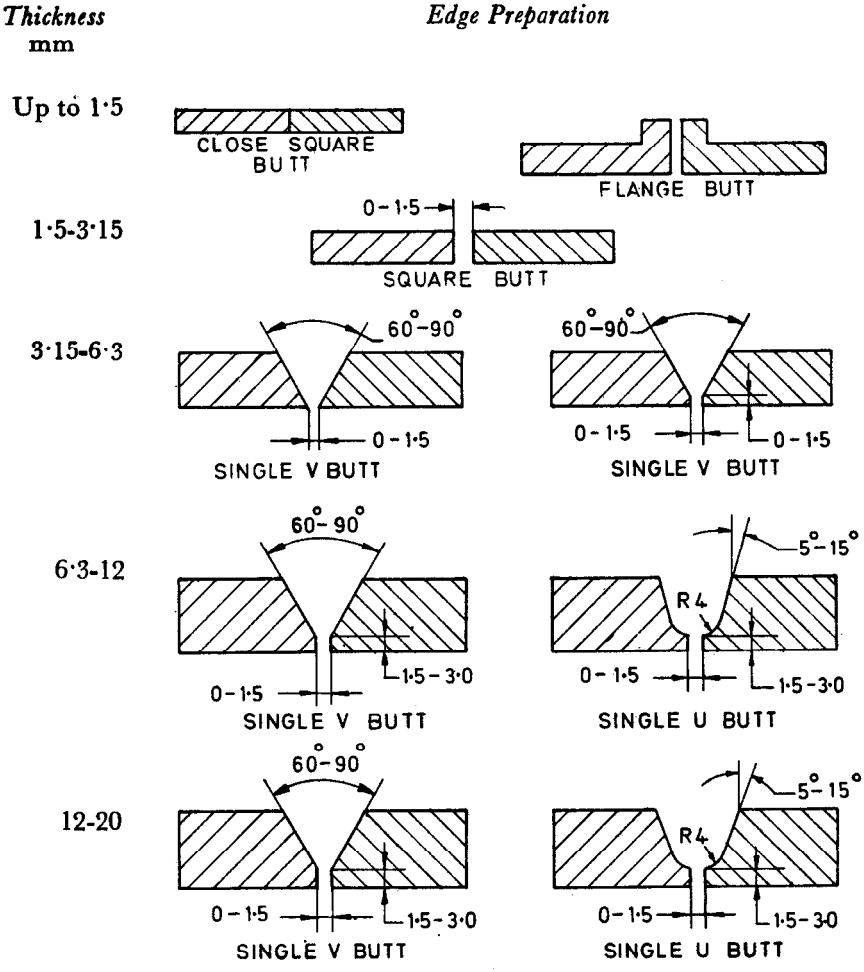
10.1 To maintain alignment during welding, the parts should be located by mechanical means or by tack welding.

10.2 If a jig is not used, the edges should be kept in alignment in assembly prior to welding by tack welds spaced at regular intervals along the joints. The tack welds should be either melted out during welding or made a part of and the same quality as the main weld. Defective tack welds should be removed before welding commences. After the tack welding, the weld should be scratch-brushed before regular welding is commenced.

10.3 Backing bars when employed may be of mild steel or copper and should be maintained in a clean condition free from grease, dirt, moisture and rust. Typical backing bars are illustrated in Fig. 4. Argon backing could also be used with advantage specially with thinner gauges. For keeping the backing bars clean, steel and copper backing bars may be given a thin coating of chromium.

11. PREHEATING

11.1 Preheating shall be necessary for most of the copper and copper alloys. For recommendations on preheating, reference may be made to Tables 2 to 5.



All dimensions in millimetres.

FIG. 1 RECOMMENDED EDGE PREPARATIONS FOR DOWNHAND BUTT WELDS

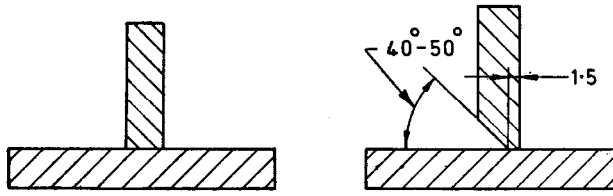
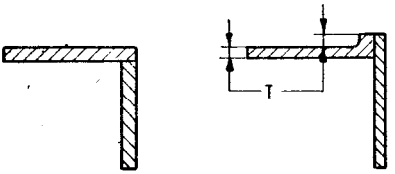
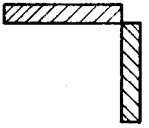
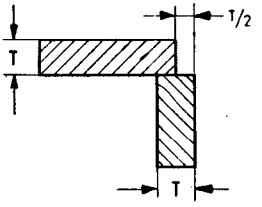
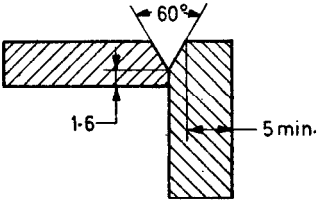
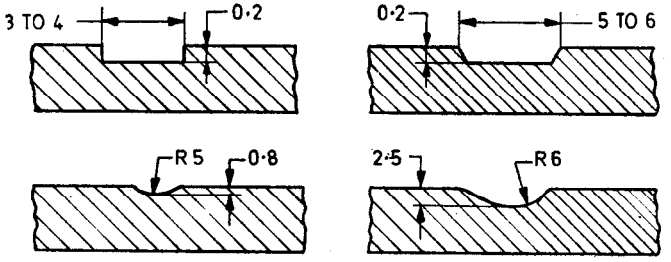


FIG. 2 TEE JOINTS

Metal Thickness mm	*Edge Preparation*	*Remarks*
Up to 1·6		Filler metal not required
Over 1·6		
Over 3·15		
Over 5		

All dimensions in millimetres.

FIG. 3 CORNER JOINTS



All dimensions in millimetres.

FIG. 4 TYPES OF TEMPORARY BACKING BARS

11.2 Copper and copper alloys being extremely good conductors of heat, heat drain causes a problem during preheat treatment. Heat drain may be minimized by the use of asbestos cloth.

12. POSTWELD HEAT TREATMENT

12.1 Postweld heat treatment is generally not necessary in case of copper and copper alloys.

12.2 In case of aluminium bronze and phosphor bronze and for certain applications where severe stress corrosion cracking may be feared, stress relief heat treatment or annealing treatment may be carried out. For recommended heat treatment temperature range, reference may be made to Table 6.

TABLE 6 POSTWELD HEAT TREATMENT FOR COPPER AND COPPER ALLOYS

Sl No.	Material	Stress Relief Heat Treatment Temp, °C*	Annealing Temperature, °C†
1.	Pure copper	—	370-650
2.	Aluminium bronze	593-650	675-815
3.	Silicon bronze	450	482-675
4.	Phosphor bronze	—	482-650
5.	Cupro nickel	530	650-816

*Heat slowly to these temperatures and hold for 1 hour, minimum.
†Heat slowly to these temperatures and hold for 15 to 30 minutes.

12.3 In case of postweld heat treatment sufficient care shall be exercised to ensure freedom from impurities in the furnace atmosphere which result in higher sulphur ingredients. Presence of such impurities can cause cracking due to formation of low temperature melting copper sulphides and nickel sulphides in the case of cupro nickel.

13. TESTING AND INSPECTION

13.1 The method of inspection should be in accordance with the requirements of appropriate Indian Standards or in the absence of such standards, by agreement between the purchaser and the fabricator.

13.2 Welds not complying with such standards shall be cut out and rewelded and reinspected.

13.3 The fabricator shall be responsible for the supply of material for testing, preparation of test piece, labour and appliances required for such testing as may be carried out in his premises by the purchaser. If such facilities are not available at his premises for carrying out such prescribed tests the fabricator shall have the tests carried out elsewhere.

(*Continued from page* 2)

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819-1957	Code of practice for resistance spot welding for light assemblies in mild steel
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2811-1964	Recommendations for manual tungsten inert-gas arc welding of stainless steel
2812-1964	Recommendations for manual tungsten inert-gas arc welding of aluminium and aluminium alloys
3023-1965	Recommended practice for building up by metal spayring
4353-1967	Recommendations for submerged-arc welding of mild steel and low alloy steels
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6409-1971	Code of practice for oxy-acetylene flame cleaning
8002-1976	Recommended procedure for welding of flexible PVC (fixible polyvinyl chloride)
8004-1976	Recommended procedure for welding of rigid PVC (rigid polyvinyl chloride)
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